

REMARKS

35 U.S.C. § 103 Rejections

The Examiner previously rejected claims 8, 10-12, 14-16 and 20 under 35 U.S.C. § 103(a) as being unpatentable over Dasgupta, et al. (U.S. Patent Publication No.: 2003/0152835, hereinafter “Dasgupta”) in view of Gurin (U.S. Patent Publication No.: 2003/0151030 A1, hereinafter “Gurin”) and claims 8 and 10-16 under 35 U.S.C. § 103(a) as being unpatentable over Dasgupta, et al. (U.S. Patent Publication No.: 2003/0152835, hereinafter “Dasgupta”) in view of Choi, et al. (U.S. Patent Publication No.: 2004/0018416, hereinafter “Choi”) and claim 9 under 35 U.S.C. § 103(a) as being unpatentable over Dasgupta in view of Gurin, as applied to claims 8, 14-16 and 20 above .

Claim 8 of the present invention relates to a process for preparing a carbon nanotube electrode which has low internal resistance, strong durability, and low equivalent series resistance (ESR), characterized in comprising the following steps:

(1) preparing an electrode material by mixing carbon nanotubes with a binder comprising sulfur or metal nanoparticles having an average particle size of 1 μ m or less, or depositing a binder comprising sulfur or metal nanoparticles having an average particle size of 1 μ m or less on the carbon nanotubes;

(2) preparing a pressed electrode material by first pressing the electrode material under a pressure from 1 to 500 atm; and

(3) subsequently pressing under a pressure from 1 to 500 atm, or heat-treating at a temperature in the range of the melting point of the sulfur or metal nanoparticles

±200°C in inert gas atmosphere, or simultaneously pressing under the said pressure and heat-treating at the said temperature in inert gas atmosphere the previously pressed electrode material that is placed on a current collector so that the carbon nanotubes are bonded to each other and simultaneously bonded to the current collector.

Meanwhile, Dasgupta relates to “an anode for a lithium battery having a conductive substrate coated with a pressed compact of spherical graphite and an ion conducting polymeric binder, comprising the inclusion of up to From 1.5 to 15% by weight of carbon nanofibers in said pressed compact” (claim 1 of Dasgupta).

In this regard, a comparison of the process of claim 8 of the present invention with the process disclosed in Dasgupta is as follows:

(1) With regard to step (1) of the present invention

The Examiner states that Dasgupta at paragraph [0023] discloses the step of “(1) preparing an electrode material by mixing carbon nanofibers with binder.”

In this regard, in Dasgupta, the electrode material used in order to prepare the anode for a lithium battery is mesophase graphite containing up to 15% by weight of carbon nanofibers (CNF) (see claim 1 and paragraph [0023] of Dasgupta). However, in the present invention, 100% of carbon nanotubes (hereinafter ‘CNT’) are the major material used for the electrode material.

Also, the CNFs used in Dasgupta are the vapor grown carbon fibers(VGCF) which have an average diameter of 0.2 μm and an average length within the range of

10-20 μm (see paragraphs [0013] and [0024] and claim 2 of Dasgupta). That is, the CNFs disclosed in Dasgupta do not comprise single-walled CNTs (SWCNT) and thin multi-walled CNTs (MWCNT). VGCFs differ from the CNTs of the present invention in that they are about 10^2 - 10^5 times thicker than the ordinary CNTs [see The Science and Technology of Carbon Nanotubes, edited by K.Tanaka et al., Elsevier, 1999, pp. 144-145].

Further, in Dasgupta, ion conducting polymeric binder is used as a binder (see claim 1 and paragraphs [0023] and [0030] - [0032] of Dasgupta). However, in the present invention, sulfur or metal nanoparticles are used as a binder binding individual CNTs.

As stated above, the CNFs disclosed in Dasgupta differ from the CNTs used in the present invention. Also, the electrode material of Dasgupta differs from the electrode material of the present invention. Therefore, it is obvious that Dasgupta does not disclose the step of preparing an electrode material by mixing or depositing a binder comprising sulfur or metal nanoparticles with CNT 100%.

(2) With regard to step (2) of the present invention

The examiner states that Dasgupta at paragraph [0012] discloses the step of "(2) preparing a pressed electrode material by first pressing the graphite, carbon nanofibers and binder."

In this regard, Dasgupta at paragraph [0012] discloses "...a conductive substrate coated with a pressed compact of spherical graphite and ion-conducting polymeric binder..." However, the examples of Dasgupta only disclose a process for preparing an anode by spreading anode paste over the copper foil. Therefore, it can be known that "the pressed compact of spherical graphite and ion-conducting polymeric binder" disclosed in Dasgupta at paragraph [0012] means the coating by rolling anode paste on the substrate by a rolling machine such as Dr. blade in the pertinent art.

In contrast, in step (2) of the present invention, a specific pressure of 1~500 atm is applied to the electrode material in order to bind CNTs by sulfur or metal nanoparticles. For your reference, in step (2), the pressure of 1-500 atm means the pressure directly applied to the electrode material prepared in step (1) by press, and thus it is a unit for the force applied to a unit area of the electrode surface. That is, 1 atm ($=101.3\text{kPa} = 101.3\text{kN/m}^2$) of the present invention does not mean that said process is proceeded under atmospheric pressure.

Therefore, the description Dasgupta at paragraph [0012] differs from step (2) of the present invention which is for binding a binder comprising sulfur or metal nanoparticles with CNTs under the specific pressure of the present invention.

That is, Dasgupta does not disclose step (2) of the present invention which prepares a pressed electrode material by binding an electrode material on a substrate

or binding CNTs with a binder comprising sulfur or metal nanoparticles of solid particles, by first pressing the electrode material under a pressure from 1 to 500 atm.

(3) With regard to step (3) of the present invention

The Examiner states that Dasgupta at paragraph [0016] discloses the step of "(3) subsequently heat-treating the previously pressed electrode material."

In this regard, Dasgupta at paragraph [0016] discloses:

"the heat and vacuum treating may be carried out after preparation of the mixture of carbon fibers, mesophase carbon particles, ionic binder and wetting of the mixture with lithium ion containing solution. According to this embodiment, the heat treating temperature may be from 45°C to 80°C."

That is, it discloses a process of heat treating at a temperature of 45°C to 80°C after preparing anode paste

As can be seen in the examples of Dasgupta, the heat-treating process disclosed in Dasgupta is performed after mixing graphite, binder and electrolyte, and before spreading it on the copper foil. It is a heat treatment for stabilizing the polymers within the anode paste.

However, step (3) of the present invention is performed in order to bind CNTs together and bind a current collector and electrode material at the same time. In

order to achieve such effect, heat treating at high temperature (a temperature in the range of the melting point of the sulfur or metal nanoparticles ±200°C) and/or pressing at high pressure (a pressure from 1 to 500 atm) is performed simultaneously or consecutively.

That is, the heat-treating of 45°C to 80°C disclosed in Dasgupta differs from the heat-treating at high temperature of the present invention. Therefore, Dasgupta does not disclose the heat-treating at high temperature and pressing at high pressure of step (3) of the present invention as claimed.

As stated above, Dasgupta does not disclose steps (1)-(3) of the present invention. That is, the process for preparing a CNT electrode comprising steps (1)-(3) of claim 8 of the present invention is not disclosed in Dasgupta at all. Therefore, the present invention cannot be easily invented from a combination of other cited references (Gurin, et al and Choi et al.) by a person having ordinary skill in the art.

Meanwhile, the Examiner states that since Gurin suggests the conductivity of the carbon nanotubes being enhanced with a metal nanoparticle coating. The Examiner also states that the use of CNTs mixed with metal nanoparticles for preparing the electrode of Dasgupta can be easily anticipated by a person having ordinary skill in the art.

In this regard, in the present invention, sulfur or metal nanoparticles are used as a binder for binding CNTs. However, Gurin merely discloses that the electric

conductivity of the carbon particles can be improved because the metal coating is deposited on the surface of the carbon particle (Gurin at paragraph [0063]), and does not disclose or suggest that metal nanoparticle can be used as a binder for binding CNTs. Therefore, a person having ordinary skill in the art cannot anticipate from Gurin that a binder comprising sulfur or metal nanoparticles is used instead of an organic binder for preparing an electrode material. Therefore, it is obvious that the present invention cannot be easily anticipated by a person having ordinary skill in the art from a combination of Dasgupta and Gurin.

Also, the examiner states that Choi discloses that metallic catalyst particles are distributed on the internal and external surface of the CNTs to present maximum reaction efficiency, and thus preparing the electrode of Dasgupta by mixing CNTs with metal nanoparticles is obvious to a person having ordinary skill in the art.

In this regard, Choi relates to depositing metal particles which are the CNT synthesis catalyst on a carbon substrate to synthesize CNTs by the chemical vapor deposition (CVD) reaction, and using the metallic catalyst particles distributed on the internal and external surface of the CNTs, resulted from the inevitable moving of the metallic catalyst particles during the high temperature CNT synthesis, as an electrode (see paragraphs [0003], [0016]. and [0020] of Choi. That is, Choi merely discloses metal particles as catalyst used in the reaction for synthesizing CNTs and does not disclose or suggest the use of the metal particles as a binder for binding CNTs. Therefore, using sulfur or metal nanoparticles as a binder instead of an

organic binder for preparing an electrode material cannot be anticipated from Choi by a person having ordinary skill in the art. Therefore, it is obvious that the present invention cannot be easily anticipated by a person having ordinary skill in the art from a combination of Dasgupta and Choi.

In conclusion, Dasgupta does not disclose or suggest steps (1)-(3) of claim 8 of the present invention and Gurin and Choi do not disclose or suggest the use as a binder for binding CNTs of sulfur or metal nanoparticles. Therefore, the present invention cannot be obvious from a combination of Dasgupta and Gurin or Dasgupta and Choi to a person having ordinary skill in the art.

Meanwhile, claim 8 of the present invention cannot be invented by combining Dasgupta and Gurin or Dasgupta and Choi, claims 9, 12-16 and 20 which depend from claim 8 cannot be obvious from the combination of Dasgupta and Gurin or Dasgupta and Choi.

As stated above, the present invention is patentable over Dasgupta to Choi. Therefore, we respectfully request for a Notice of Allowance.

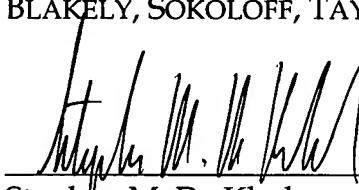
Applicant respectfully submits that the present application is in condition for allowance. If the Examiner believes a telephone conference would expedite or assist in the allowance of the present application, the Examiner is invited to call Stephen M. De Klerk at (408) 720-8300.

Please charge any shortages and credit any overages to Deposit Account No. 02-2666. Any necessary extension of time for response not already requested is hereby requested. Please charge any corresponding fee to Deposit Account No. 02-2666.

If there are any additional charges, please charge Deposit Account No. 02-2666.

Respectfully submitted,

BLAKELY, SOKOLOFF, TAYLOR & ZAFMAN LLP



Stephen M. De Klerk
Reg. No. 46,503

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12400 Wilshire Blvd.
Seventh Floor
Los Angeles, CA 90025-1026
(408) 720-8300